

CHAPTER 14 (Odd)

3. a. $(377)(10) \cos 377t = 3770 \cos 377t$
 b. $(754)(0.6) \cos(754t + 20^\circ) = 452.4 \cos(754t + 20^\circ)$
 c. $(\sqrt{2} 20)(157) \cos(157t - 20^\circ) = 4440.63 \cos(157t - 20^\circ)$
 d. $(-200)(1) \cos(t + 180^\circ) = -200 \cos(t + 180^\circ) = 200 \cos t$
5. a. $V_m = I_m R = (0.03 \text{ A})(7 \times 10^3 \Omega) = 210 \text{ V}$
 $v = 210 \sin 754t$
 b. $V_m = I_m R = (2 \times 10^{-3} \text{ A})(7 \times 10^3 \Omega) = 14.8 \text{ V}$
 $v = 14.8 \sin(400t - 120^\circ)$
 c. $i = 6 \times 10^{-6} \sin(\omega t - 2^\circ + 90^\circ) = 6 \times 10^{-6} \sin(\omega t + 88^\circ)$
 $V_m = I_m R = (6 \times 10^{-6} \text{ A})(7 \times 10^3 \Omega) = 42 \times 10^{-3} \text{ V}$
 $v = 42 \times 10^{-3} \sin(\omega t + 88^\circ)$
 d. $i = 0.004 \sin(\omega t - 90^\circ + 90^\circ + 180^\circ) = 0.004 \sin(\omega t + 180^\circ)$
 $V_m = I_m R = (4 \times 10^{-3} \text{ A})(7 \times 10^3 \Omega) = 28 \text{ V}$
 $v = 28 \sin(\omega t + 180^\circ)$
7. a. $L = \frac{X_L}{2\pi f} = \frac{20 \Omega}{2\pi(2 \text{ Hz})} = 1.592 \text{ H}$ b. $L = \frac{X_L}{2\pi f} = \frac{1000 \Omega}{2\pi(60 \text{ Hz})} = 2.654 \text{ H}$
 c. $L = \frac{X_L}{2\pi f} = \frac{5280 \Omega}{2\pi(1000 \text{ Hz})} = 0.841 \text{ H}$
9. a. $V_m = I_m X_L = (5 \text{ A})(20 \Omega) = 100 \text{ V}$
 $v = 100 \sin(\omega t + 90^\circ)$ b. $V_m = I_m X_L = (0.4 \text{ A})(20 \Omega) = 8 \text{ V}$
 $v = 8 \sin(\omega t + 150^\circ)$
 c. $i = 6 \sin(\omega t + 150^\circ)$, $V_m = I_m X_L = (6 \text{ A})(20 \Omega) = 120 \text{ V}$
 $v = 120 \sin(\omega t + 240^\circ) = 120 \sin(\omega t - 120^\circ)$
 d. $i = 3 \sin(\omega t + 100^\circ)$, $V_m = I_m X_L = (3 \text{ A})(20 \Omega) = 60 \text{ V}$
 $v = 60 \sin(\omega t + 190^\circ)$
11. a. $I_m = \frac{V_m}{X_L} = \frac{50 \text{ V}}{50 \Omega} = 1 \text{ A}$, $i = 1 \sin(\omega t - 90^\circ)$
 b. $I_m = \frac{V_m}{X_L} = \frac{30 \text{ V}}{50 \Omega} = 0.6 \text{ A}$, $i = 0.6 \sin(\omega t - 70^\circ)$
 c. $v = 40 \sin(\omega t + 100^\circ)$
 $I_m = \frac{V_m}{X_L} = \frac{40 \text{ V}}{50 \Omega} = 0.8 \text{ A}$, $i = 0.8 \sin(\omega t + 10^\circ)$

- d. $v = 80 \sin(377t + 220^\circ)$
 $I_m = \frac{V_m}{X_L} = \frac{80 \text{ V}}{50 \Omega} = 1.6 \text{ A}, i = 1.6 \sin(377t + 130^\circ)$
13. a. $X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(0 \text{ Hz})(5 \times 10^{-6} \text{ F})} = \infty \Omega$
- b. $X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(60 \text{ Hz})(5 \times 10^{-6} \text{ F})} = 530.79 \Omega$
- c. $X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(120 \text{ Hz})(5 \times 10^{-6} \text{ F})} = 265.39 \Omega$
- d. $X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(1800 \text{ Hz})(5 \times 10^{-6} \text{ F})} = 17.693 \Omega$
- e. $X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(24 \times 10^3 \text{ Hz})(5 \times 10^{-6} \text{ F})} = 1.327 \Omega$
15. a. $f = \frac{1}{2\pi CX_C} = \frac{1}{2\pi(50 \times 10^{-6} \text{ F})(342 \Omega)} = 9.31 \text{ Hz}$
- b. $f = \frac{1}{2\pi CX_C} = \frac{1}{2\pi(50 \times 10^{-6} \text{ F})(684 \Omega)} = 4.66 \text{ Hz}$
- c. $f = \frac{1}{2\pi CX_C} = \frac{1}{2\pi(50 \times 10^{-6} \text{ F})(171 \Omega)} = 18.62 \text{ Hz}$
- d. $f = \frac{1}{2\pi CX_C} = \frac{1}{2\pi(50 \times 10^{-6} \text{ F})(2000 \Omega)} = 1.59 \text{ Hz}$
17. a. $v = 30 \sin 200t, X_C = \frac{1}{\omega C} = \frac{1}{(200)(1 \times 10^{-6})} = 5 \text{ k}\Omega$
 $I_m = \frac{V_m}{X_C} = \frac{30 \text{ V}}{5 \text{ k}\Omega} = 6 \text{ mA}, i = 6 \times 10^{-3} \sin(200t + 90^\circ)$
- b. $v = 90 \sin 377t, X_C = \frac{1}{\omega C} = \frac{1}{(377)(1 \times 10^{-6})} = 2.65 \text{ k}\Omega$
 $I_m = \frac{V_m}{X_C} = \frac{90 \text{ V}}{2,650 \Omega} = 33.96 \text{ mA}, i = 33.96 \times 10^{-3} \sin(377t + 90^\circ)$
- c. $v = 120 \sin(374t + 210^\circ), X_C = \frac{1}{\omega C} = \frac{1}{(374)(1 \times 10^{-6})} = 2.67 \text{ k}\Omega$
 $I_m = \frac{V_m}{X_C} = \frac{120 \text{ V}}{2,670 \Omega} = 44.94 \text{ mA}, i = 44.94 \times 10^{-3} \sin(374t + 300^\circ)$

$$d. \quad v = 70 \sin(800t + 70^\circ), X_C = \frac{1}{\omega C} = \frac{1}{(800)(1 \times 10^{-6})} = 1.25 \text{ k}\Omega$$

$$I_m = \frac{V_m}{X_C} = \frac{70 \text{ V}}{1250 \Omega} = 56 \text{ mA}, i = 56 \times 10^{-3} \sin(\omega t + 160^\circ)$$

$$19. \quad a. \quad i = 0.2 \sin 300t, X_C = \frac{1}{\omega C} = \frac{1}{(300)(0.5 \times 10^{-6})} = 6.67 \text{ k}\Omega$$

$$V_m = I_m X_C = (0.2 \text{ A})(6,670 \Omega) = 1334 \text{ V}, v = 1334 \sin(300t - 90^\circ)$$

$$b. \quad i = 7 \times 10^{-3} \sin 377t, X_C = \frac{1}{\omega C} = \frac{1}{(377)(0.5 \times 10^{-6})} = 5.31 \text{ k}\Omega$$

$$V_m = I_m X_C = (7 \times 10^{-3} \text{ A})(5.31 \times 10^3 \Omega) = 37.17 \text{ V}$$

$$v = 37.17 \sin(377t - 90^\circ)$$

$$c. \quad i = 0.048 \sin(754t + 90^\circ), X_C = \frac{1}{\omega C} = \frac{1}{(754)(0.5 \times 10^{-6})} = 2.65 \text{ k}\Omega$$

$$V_m = I_m X_C = (48 \times 10^{-3} \text{ A})(2.65 \times 10^3 \Omega) = 127.2 \text{ V}$$

$$v = 127.2 \sin 754t$$

$$d. \quad i = 80 \times 10^{-3} \sin(1600t - 80^\circ), X_C = \frac{1}{\omega C} = \frac{1}{(1600)(0.5 \times 10^{-6})} = 1.25 \text{ k}\Omega$$

$$V_m = I_m X_C = (80 \times 10^{-3} \text{ A})(1.25 \times 10^3 \Omega) = 100 \text{ V}$$

$$v = 100 \sin(1600t - 170^\circ)$$

$$21. \quad a. \quad \left. \begin{array}{l} i = 5 \sin(\omega t + 90^\circ) \\ v = 2000 \sin \omega t \end{array} \right\} i \text{ leads } v \text{ by } 90^\circ \Rightarrow C$$

$$X_C = \frac{V_m}{I_m} = \frac{2000 \text{ V}}{5 \text{ A}} = 400 \Omega$$

$$b. \quad \left. \begin{array}{l} i = 2 \sin(157t + 60^\circ) \\ v = 80 \sin(157t + 150^\circ) \end{array} \right\} v \text{ leads } i \text{ by } 90^\circ \Rightarrow L$$

$$X_L = \frac{V_m}{I_m} = \frac{80 \text{ V}}{2 \text{ A}} = 40 \Omega, L = \frac{X_L}{\omega} = \frac{40 \Omega}{157 \text{ rad/s}} = 254.78 \text{ mH}$$

$$c. \quad \left. \begin{array}{l} v = 35 \sin(\omega t - 20^\circ) \\ i = 7 \sin(\omega t - 20^\circ) \end{array} \right\} \text{ in phase } \Rightarrow R$$

$$R = \frac{V_m}{I_m} = \frac{35 \text{ V}}{7 \text{ A}} = 5 \Omega$$

$$25. \quad X_L = 2\pi fL = R$$

$$L = \frac{R}{2\pi f} = \frac{10,000 \Omega}{2\pi(5 \times 10^3 \text{ Hz})} = 318.47 \text{ mH}$$

27. $X_C = X_L$
 $\frac{1}{2\pi fC} = 2\pi fL \Rightarrow C = \frac{1}{4\pi^2 f^2 L} = \frac{1}{4(9.86)(2500 \times 10^6)(2 \times 10^{-3})} = 5.067 \text{ nF}$
29. a. $P = \frac{V_m I_m}{2} \cos \theta = \frac{(5 \text{ A})(2000 \text{ V})}{2} \cos 90^\circ = 0 \text{ W}$
- b. $\cos \theta = 0 \Rightarrow 0 \text{ W}$
- c. $P = \frac{(35 \text{ V})(7 \text{ A})}{2} \cos 0^\circ = 122.5 \text{ W}$
31. $R = \frac{V_m}{I_m} = \frac{48 \text{ V}}{8 \text{ A}} = 6 \Omega, P = I^2 R = \left[\frac{8 \text{ A}}{\sqrt{2}} \right]^2 6 \Omega = 192 \text{ W}$
 $P = \frac{V_m I_m}{2} \cos \theta = \frac{(48 \text{ V})(8 \text{ A})}{2} \cos 0^\circ = 192 \text{ W}$
 $P = VI \cos \theta = \left[\frac{48 \text{ V}}{\sqrt{2}} \right] \left[\frac{8 \text{ A}}{\sqrt{2}} \right] \cos 0^\circ = 192 \text{ W}$
33. $P = \frac{V_m I_m}{2} \cos \theta$
 $500 \text{ W} = \frac{(50 \text{ V})I_m}{2} (0.5) \Rightarrow I_m = 40 \text{ A}$
 $i = 40 \sin(\omega t - 50^\circ)$
35. a. $I_m = \frac{V_m}{X_L} = \frac{100 \text{ V}}{50 \Omega} = 2 \text{ A}, i = 2 \sin(157t - 60^\circ)$
- b. $X_L = \frac{V_m}{I_m} = \frac{100 \text{ V}}{2 \text{ A}} = 50 \Omega, L = \frac{X_L}{\omega} = \frac{50 \Omega}{157 \text{ rad/s}} = 318.47 \text{ mH}$
- c. $L \Rightarrow 0 \text{ W}$
37. a. $X_{C_1} = \frac{1}{2\pi fC_1} = \frac{1}{\omega C_1} = \frac{1}{(10^4 \text{ rad/s})(2 \mu\text{F})} = 50 \Omega$
 $X_{C_2} = \frac{1}{\omega C_2} = \frac{1}{(10^4)(8 \mu\text{F})} = 12.5 \Omega$
 $E = 100 \text{ V} \angle 60^\circ, I_1 = \frac{E}{Z_{C_1}} = \frac{100 \text{ V} \angle 60^\circ}{50 \Omega \angle -90^\circ} = 2 \text{ A} \angle 150^\circ$
 $I_2 = \frac{E}{Z_{C_2}} = \frac{100 \text{ V} \angle 60^\circ}{12.5 \Omega \angle -90^\circ} = 8 \text{ A} \angle 150^\circ$
 $i_1 = \sqrt{2} 2 \sin(10^4 t + 150^\circ) = 2.828 \sin(10^4 t + 150^\circ)$
 $i_2 = \sqrt{2} 8 \sin(10^4 t + 150^\circ) = 11.312 \sin(10^4 t + 150^\circ)$
- b. $I_s = I_1 + I_2 = 2 \text{ A} \angle 150^\circ + 8 \text{ A} \angle 150^\circ = 10 \text{ A} \angle 150^\circ$
 $i_s = \sqrt{2} 10 \sin(10^4 t + 150^\circ) = 14.14 \sin(10^4 t + 150^\circ)$

39. a. $5.0 \angle 36.87^\circ$ b. $2.83 \angle 45^\circ$ c. $16.38 \angle 77.66^\circ$
d. $806.23 \angle 82.87^\circ$ e. $1077.03 \angle 21.80^\circ$ f. $0.00658 \angle 81.25^\circ$
g. $11.78 \angle -49.82^\circ$ h. $8.94 \angle 153.43^\circ$ i. $61.85 \angle -104.04^\circ$
j. $101.53 \angle -39.81^\circ$ k. $4,326.66 \angle 123.69^\circ$ l. $25.495 \times 10^{-3} \angle -78.69^\circ$
41. a. $15.033 \angle 86.19^\circ$ b. $60.208 \angle 4.76^\circ$ c. $0.30 \angle 88.09^\circ$
d. $2002.5 \angle -87.14^\circ$ e. $86.182 \angle 93.73^\circ$ f. $38.694 \angle -94.0^\circ$
43. a. $11.8 + j7.0$ b. $151.90 + j49.90$ c. $4.72 \times 10^{-6} + j71$
d. $5.20 + j1.60$ e. $209.30 + j311.0$ f. $-21.20 + j12.0$
g. $6 \angle 20^\circ + 8 \angle 80^\circ = (5.64 + j2.05) + (1.39 + j7.88) = 7.03 + j9.93$
h. $(29.698 + j29.698) + (31.0 + j53.69) - (-35 + j60.62) = 95.698 + j22.768$
45. a. $6.0 \angle -50.0^\circ$ b. $0.2 \times 10^{-3} \angle 140^\circ$ c. $109.0 \angle -230.0^\circ$
d. $76.471 \angle -80.0^\circ$ e. $(11.314 \angle 45^\circ)/(2.828 \angle 45^\circ) = 40 \angle 0^\circ$
f. $42.76 \angle 79.22^\circ/60.30 \angle 95.71^\circ = 0.71 \angle -16.49^\circ$
g. $(0.05 + j0.25)/(8 - j60) = 0.255 \angle 78.69^\circ/60.53 \angle -82.41^\circ = 4.21 \times 10^{-3} \angle 161.10^\circ$
h. $(7.5 \angle -126.87^\circ)/(0.4123 \angle -75.96^\circ) = 18.191 \angle -50.91^\circ$
47. a. $x + j4 + 3x + jy - j7 = 16$
 $(x + 3x) + j(4 + y - 7) = 16 + j0$
 $x + 3x = 16$ $4 + y - 7 = 0$
 $4x = 16$ $y = +7 - 4$
 $x = 4$ $y = 3$
- b. $(10 \angle 20^\circ)(x \angle -60^\circ) = 30.64 - j25.72$
 $10x \angle -40^\circ = 40 \angle -40^\circ$
 $10x = 40$
 $x = 4$

c. $\frac{5x + j10}{2 - jy}$

$$10x + j20 - j5xy - j^2 10y = 90 - j70$$

$$(10x + 10y) + j(20 - 5xy) = 90 - j70$$

$$10x + 10y = 90$$

$$x + y = 9$$

$$x = 9 - y \Rightarrow$$

$$20 - 5xy = -70$$

$$20 - 5(9 - y)y = -70$$

$$5y(9 - y) = 90$$

$$y^2 - 9y + 18 = 0$$

$$y = \frac{-(-9) \pm \sqrt{(-9)^2 - 4(1)(18)}}{2}$$

$$y = \frac{9 \pm 3}{2} = 6, 3$$

For $y = 6, x = 3$

$y = 3, x = 6$

$(x = 3, y = 6)$ or $(x = 6, y = 3)$

d. $\frac{80 \angle 0^\circ}{40 \angle \theta} = 4 \angle -\theta = 3.464 - j2 = 4 \angle -30^\circ$
 $\theta = 30^\circ$

49. a. $56.569 \sin(377t + 20^\circ)$

b. $169.68 \sin 377t$

c. $11.314 \times 10^{-3} \sin(377t + 120^\circ)$

d. $7.07 \sin(377t + 90^\circ)$

e. $1696.8 \sin(377t - 120^\circ)$

f. $6000 \sin(377t - 180^\circ)$

51. $i_s = i_1 + i_2 \Rightarrow i_1 = i_s - i_2$

(Using peak values) $= (20 \times 10^{-6} \text{ A } \angle 90^\circ) - (6 \times 10^{-6} \text{ A } \angle -60^\circ)$

and $i_1 = (0 + j2 \times 10^{-5}) - (3 \times 10^{-6} - j5.196 \times 10^{-6})$

$= -0.3 \times 10^{-5} + j2.5196 \times 10^{-5} = 2.537 \times 10^{-5} \angle 96.79^\circ$

$= 2.537 \times 10^{-5} \sin(\omega t + 96.79^\circ)$

53. (Using effective values)

$I_s = I_1 + I_2 + I_3 = 4.240 \text{ mA } \angle 180^\circ + 5.656 \text{ mA } \angle 0^\circ + 11.312 \text{ mA } \angle 0^\circ$

$= -4.242 \text{ mA} + 16.968 \text{ mA} = 12.726 \text{ mA } \angle 0^\circ$

$i_s = 18 \times 10^{-3} \sin 377t$

CHAPTER 14 (Even)

4. a. $I_m = V_m/R = 150 \text{ V}/5 \Omega = 30 \text{ A}$, $i = 30 \sin 377t$
 b. $I_m = V_m/R = 30 \text{ V}/5 \Omega = 6 \text{ A}$, $i = 6 \sin(377t + 20^\circ)$
 c. $I_m = V_m/R = 40 \text{ V}/5 \Omega = 8 \text{ A}$, $i = 8 \sin(\omega t + 100^\circ)$
 d. $I_m = V_m/R = 80 \text{ V}/5 \Omega = 16 \text{ A}$, $i = 16 \sin(\omega t + 220^\circ)$
6. a. 0Ω
 b. $X_L = 2\pi fL = 2\pi Lf = (6.28)(2 \text{ H})f = 12.56f = 12.56(25 \text{ Hz}) = 314 \Omega$
 c. $X_L = 12.56f = 12.56(60 \text{ Hz}) = 753.6 \Omega$
 d. $X_L = 12.56f = 12.56(2000 \text{ Hz}) = 25.13 \text{ k}\Omega$
 e. $X_L = 12.56f = 12.56(10^5 \text{ Hz}) = 1.256 \text{ M}\Omega$
8. a. $X_L = 2\pi fL \Rightarrow f = \frac{X_L}{2\pi L} = \frac{X_L}{(6.28)(10 \text{ H})} = \frac{X_L}{62.8}$
 $f = \frac{50 \Omega}{62.8} \cong 0.796 \text{ Hz}$
 b. $f = \frac{X_L}{62.8} = \frac{3770 \Omega}{62.8} = 60.03 \text{ Hz}$ c. $f = \frac{X_L}{62.8} = \frac{15,700 \Omega}{62.8} = 250 \text{ Hz}$
 d. $f = \frac{X_L}{62.8} = \frac{243 \Omega}{62.8} = 3.87 \text{ Hz}$
10. a. $X_L = \omega L = (300 \text{ rad/s})(0.1 \text{ H}) = 3 \Omega$
 $V_m = I_m X_L = (30 \text{ A})(3 \Omega) = 90 \text{ V}$
 $v = 90 \sin(30t + 90^\circ)$
 b. $X_L = \omega L = (377 \text{ rad/s})(0.1 \text{ H}) = 37.7 \Omega$
 $V_m = I_m X_L = (6 \times 10^{-3} \text{ A})(37.7 \Omega) = 226.2 \text{ mV}$
 $v = 226.2 \times 10^{-3} \sin(377t + 90^\circ)$
 c. $X_L = \omega L = (400 \text{ rad/s})(0.1 \text{ H}) = 40 \Omega$
 $V_m = I_m X_L = (5 \times 10^{-6} \text{ A})(40 \Omega) = 200 \mu\text{V}$
 $v = 200 \times 10^{-6} \sin(400t + 110^\circ)$
 d. $i = 4 \sin(20t + 200^\circ)$
 $X_L = \omega L = (20 \text{ rad/s})(0.1 \text{ H}) = 2 \Omega$
 $V_m = I_m X_L = (4 \text{ A})(2 \Omega) = 8 \text{ V}$
 $v = 8 \sin(20t + 290^\circ) = 8 \sin(20t - 70^\circ)$

12. a. $X_L = \omega L = (60 \text{ rad/s})(0.2 \text{ H}) = 12 \Omega$
 $I_m = V_m/X_L = 1.5 \text{ V}/12 \Omega = 0.125 \text{ A}$
 $i = 0.125 \sin(60t - 90^\circ)$
- b. $X_L = \omega L = (1 \text{ rad/s})(0.2 \text{ H}) = 0.2 \Omega$
 $I_m = V_m/X_L = 16 \text{ mV}/0.2 \Omega = 80 \text{ mA}$
 $i = 80 \times 10^{-3} \sin(t + 4^\circ - 90^\circ) = 80 \times 10^{-3} \sin(t - 86^\circ)$
- c. $v = 4.8 \sin(0.05t + 230^\circ)$
 $X_L = \omega L = (0.05 \text{ rad/s})(0.2 \text{ H}) = 0.01 \Omega$
 $I_m = V_m/X_L = 4.8 \text{ V}/0.01 \Omega = 480 \text{ A}$
 $i = 480 \sin(0.05t + 230^\circ - 90^\circ) = 480 \sin(0.05t + 140^\circ)$
- d. $v = 9 \times 10^{-3} \sin(377t + 90^\circ)$
 $X_L = \omega L = (377 \text{ rad/s})(0.2 \text{ H}) = 75.4 \Omega$
 $I_m = V_m/X_L = 9 \text{ mV}/75.4 \Omega = 0.119 \text{ mA}$
 $i = 0.119 \times 10^{-3} \sin 377t$
14. a. $C = \frac{1}{2\pi f X_C} = \frac{1}{6.28(60 \text{ Hz})(250 \Omega)} = 10.62 \mu\text{F}$
- b. $C = \frac{1}{2\pi f X_C} = \frac{1}{6.28(312 \text{ Hz})(55 \Omega)} = 9.28 \mu\text{F}$
- c. $C = \frac{1}{2\pi f X_C} = \frac{1}{6.28(25 \text{ Hz})(10 \Omega)} = 636.94 \mu\text{F}$
16. a. $I_m = V_m/X_C = 100 \text{ V}/2.5 \Omega = 40 \text{ A}$
 $i = 40 \sin(\omega t + 90^\circ)$
- b. $I_m = V_m/X_C = 0.4 \text{ V}/2.5 \Omega = 0.16 \text{ A}$
 $i = 0.16 \sin(\omega t + 110^\circ)$
- c. $v = 8 \sin(\omega t + 100^\circ)$
 $I_m = V_m/X_C = 8 \text{ V}/2.5 \Omega = 3.2 \text{ A}$
 $i = 3.2 \sin(\omega t + 190^\circ)$
- d. $v = -70 \sin(\omega t + 40^\circ) = 70 \sin(\omega t + 220^\circ)$
 $I_m = V_m/X_C = 70 \text{ V}/2.5 \Omega = 28 \text{ A}$
 $i = 28 \sin(\omega t + 310^\circ) = 28 \sin(\omega t - 50^\circ)$
18. a. $V_m = I_m X_C = (50 \text{ A})(10 \Omega) = 500 \text{ V}$
 $v = 500 \sin(\omega t - 90^\circ)$
- b. $V_m = I_m X_C = (40 \text{ A})(10 \Omega) = 400 \text{ V}$
 $v = 400 \sin(\omega t - 30^\circ)$
- c. $i = -6 \sin(\omega t - 30^\circ) = 6 \sin(\omega t + 150^\circ)$
 $V_m = I_m X_C = (6 \text{ A})(10 \Omega) = 60 \text{ V}$
 $v = 60 \sin(\omega t + 60^\circ)$
- d. $i = 3 \sin(\omega t + 100^\circ)$
 $V_m = I_m X_C = (3 \text{ A})(10 \Omega) = 30 \text{ V}$
 $v = 30 \sin(\omega t + 10^\circ)$
20. a. v leads i by $90^\circ \Rightarrow L$, $X_L = V_m/I_m = 550 \text{ V}/11 \text{ A} = 50 \Omega$
 $L = \frac{X_L}{\omega} = \frac{50 \Omega}{377 \text{ rad/s}} = 132.63 \text{ mH}$

b. i leads v by $90^\circ \Rightarrow C, X_C = V_m/I_m = 36 \text{ V}/4 \text{ A} = 9 \Omega$

$$C = \frac{1}{\omega X_C} = \frac{1}{(754 \text{ rad/s})(9 \Omega)} = 147.36 \mu\text{F}$$

c. v and i are in phase $\Rightarrow R$

$$R = \frac{V_m}{I_m} = \frac{10.5 \text{ V}}{1.5 \text{ A}} = 7 \Omega$$

24. $X_C = \frac{1}{2\pi fC} = R \Rightarrow f = \frac{1}{2\pi RC} = \frac{1}{2\pi(2 \times 10^3 \Omega)(1 \times 10^{-6} \text{ F})} = \frac{1}{12.56 \times 10^{-3}} \approx 79.62 \text{ Hz}$

26. $X_C = X_L$

$$\frac{1}{2\pi fC} = 2\pi fL$$

$$f^2 = \frac{1}{4\pi^2 LC}$$

and $f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(10 \times 10^{-3} \text{ H})(1 \times 10^{-6} \text{ F})}} = 1.592 \text{ kHz}$

28. a. $P = \frac{V_m I_m}{2} \cos \theta = \frac{(550 \text{ V})(11 \text{ A})}{2} \cos 90^\circ = () (0) = 0 \text{ W}$

b. $P = \frac{V_m I_m}{2} \cos \theta = \frac{(36 \text{ V})(4 \text{ A})}{2} \cos 90^\circ = () (0) = 0 \text{ W}$

c. $P = \frac{V_m I_m}{2} \cos \theta = \frac{(10.5 \text{ V})(1.5 \text{ A})}{2} \cos 0^\circ = 7.875 \text{ W}$

30. a. $P = \frac{(60 \text{ V})(15 \text{ A})}{2} \cos 30^\circ = 389.7 \text{ W}, F_p = 0.866$

b. $P = \frac{(50 \text{ V})(2 \text{ A})}{2} \cos 60^\circ = 25 \text{ W}, F_p = 0.5$

c. $P = \frac{(50 \text{ V})(3 \text{ A})}{2} \cos 30^\circ = 64.95 \text{ W}, F_p = 0.866$

d. $P = \frac{(75 \text{ V})(0.08 \text{ A})}{2} \cos 30^\circ = 2.598 \text{ W}, F_p = 0.866$

32. $P = 100 \text{ W}: F_p = \cos \theta = P/VI = 100 \text{ W}/(150 \text{ V})(2 \text{ A}) = 0.333$

$P = 0 \text{ W}: F_p = \cos \theta = 0$

$P = 300 \text{ W}: F_p = \frac{300}{300} = 1$

34. a. $I_m = E_m/R = 30 \text{ V}/3 \Omega = 10 \text{ A}, i = 10 \sin(377t + 20^\circ)$

- b. $P = I^2 R = \left[\frac{10 \text{ A}}{\sqrt{2}} \right]^2 3 \Omega = 150 \text{ W}$
- c. $T = \frac{2\pi}{\omega} = \frac{6.28}{377 \text{ rad/s}} = 16.67 \text{ ms}$
 $6(16.67 \text{ ms}) = 100.02 \text{ ms} \cong 0.1 \text{ s}$
36. a. $E_m = I_m X_C = (3 \text{ A})(400 \Omega) = 1200 \text{ V}$
 $e = 1200 \sin(377t - 20^\circ - 90^\circ) = 1200 \sin(377t - 110^\circ)$
- b. $C = \frac{1}{\omega X_C} = \frac{1}{(377 \text{ rad/s})(400 \Omega)} = 6.63 \mu\text{F}$
- c. $P = 0 \text{ W}$
38. a. $L_1 \parallel L_2 = 4 \text{ mH} \parallel 12 \text{ mH} = 3 \text{ mH}$
 $X_{L_T} = 2\pi f L_T = 2\pi(10^3 \text{ Hz})(3 \text{ mH}) = 18.84 \Omega$
 $V_m = I_m X_{L_T} = (\sqrt{2} 6 \text{ A})(18.84 \Omega) = \sqrt{2} 113.04 \text{ V}$
and $v_s = \sqrt{2} 113.04 \sin(10^3 t + 30^\circ + 90^\circ)$
or $v_s = 159.86 \sin(10^3 t + 120^\circ)$
- b. $I_{m_1} = \frac{V_m}{X_{L_1}}, X_{L_1} = 2\pi f L_1 = 2\pi(10^3 \text{ Hz})(4 \text{ mH}) = 25.13 \Omega$
 $I_{m_1} = \frac{159.86 \text{ V}}{25.13 \Omega} = 6.36 \text{ A}$
and $i_1 = 6.36 \sin(10^3 t + 30^\circ)$
 $X_{L_2} = 2\pi f L_2 = 2\pi(10^3 \text{ Hz})(12 \text{ mH}) = 75.398 \Omega$
 $I_{m_2} = \frac{159.86 \text{ V}}{75.398 \Omega} = 2.12 \text{ A}$
and $i_2 = 2.12 \sin(10^3 t + 30^\circ)$
40. a. $5.196 + j3.0$ b. $6.946 + j39.392$
- c. $2530.95 + j6953.73$ d. $3.961 \times 10^{-4} + j5.567 \times 10^{-5}$
- e. $0.007 + j0.039$ f. $8.561 \times 10^{-3} + j3.634 \times 10^{-3}$
- g. $-56.292 + j32.50$ h. $-0.849 + j0.849$
- i. $-469.846 - j171.01$ j. $5177.04 - j3625.0$
- k. $-4.313 - j6.160$ l. $0.005142 - j0.006128$
42. a. $12.951 + j1.133$ b. $8.374 + j159.781$
- c. $6.996 \times 10^{-6} + j2.443 \times 10^{-7}$ d. $-8.688 + j0.455$

- e. $75.815 - j5.301$ f. $-34.514 - j394.493$
44. a. $-12.0 + j34.0$ b. $(29.2 + j19.6)(7 + j6) = 86.80 + j312.40$
- c. $-0.0160 - j0.008$
- d. $(447.214 \angle -26.565^\circ)(0.5 \angle -91.146^\circ)(3.162 \angle 108.435^\circ) = 707.045 \angle -9.276^\circ$
- e. $8.0 \angle 82.0^\circ$ f. $49.68 \angle -64.0^\circ$
- g. $0.040 \angle 260^\circ$ h. $-16,740 \angle 160^\circ$
46. a. $\frac{10 - j5}{1 + j0} = 10.0 - j5.0$
- b. $\frac{8 \angle 60^\circ}{102 + j100} = \frac{8 \angle 60^\circ}{142.843 \angle 44.433^\circ} = 0.056 \angle 15.567^\circ$
- c. $\frac{(6 \angle 20^\circ)(120 \angle -40^\circ)(5 \angle 53.13^\circ)}{2 \angle -30^\circ} = \frac{3600 \angle 33.13^\circ}{2 \angle -30^\circ} = 1800 \angle 63.13^\circ$
- d. $\frac{(0.16 \angle 120^\circ)(300 \angle 40^\circ)}{9.487 \angle 71.565^\circ} = \frac{48 \angle 160^\circ}{9.487 \angle 71.565^\circ} = 5.06 \angle 88.435^\circ$
- e. $\left[\frac{1}{4 \times 10^{-4} \angle 20^\circ} \right] \left[\frac{8}{j(j^2)} \right] \left[\frac{1}{36 - j30} \right]$
 $(2500 \angle -20^\circ) \left[\frac{8}{-j} \right] \left[\frac{1}{46.861 \angle -39.81^\circ} \right]$
 $(2500 \angle -20^\circ)(8j)(0.0213 \angle 39.81^\circ) = 426 \angle 109.81^\circ$
48. a. $100.0 \angle 30^\circ$ b. $0.250 \angle -40^\circ$
- c. $70.71 \angle -90^\circ$ d. $29.69 \angle 0^\circ$
- e. $4.242 \times 10^{-6} \angle 90^\circ$ f. $2.546 \times 10^{-6} \angle 70^\circ$
50. (Using peak values)
- $$e_{in} = v_a + v_b \Rightarrow v_a = e_{in} - v_b$$
- $$= 60 \text{ V} \angle 20^\circ - 20 \text{ V} \angle 0^\circ$$
- $$= (56.381 + j20.521) - (20 + j0)$$
- $$= 36.381 + j20.52$$
- $$= 41.769 \text{ V} \angle 29.43^\circ$$
- and $e_{in} = 41.769 \sin(377t + 29.43^\circ)$
52. $e = v_a + v_b + v_c$
- $$= 60 \text{ V} \angle 30^\circ + 30 \text{ V} \angle -30^\circ + 40 \text{ V} \angle 120^\circ$$
- $$= (51.96 + j30) + (25.98 - j15) + (-20 + j34.64)$$
- $$= 57.94 + j49.64$$
- $$= 76.297 \text{ V} \angle 40.59^\circ$$
- and $e = 76.297 \sin(\omega t + 40.59^\circ)$